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A Case Research on Vulnerability of logistics system in the Tianjin port

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Abstract

From the view of Analysis of port logistics system, this paper put forward the connotation of vulnerability and defined the contents of the port logistics system vulnerability studies. On this basis of above , I established the assessment methods on port logistics system vulnerability. Besides, take Tianjin for cases I analyses the geographical factor and the natural environment, infrastructure factors, port logistics support factors, operator status, port logistics management and service level by hierarchy analysis method and vulnerability calculation .All above established the foundation for the logistics system vulnerability.

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Port is an important component of logistics chain, it is indispensable to the development of logistics services. At present, Transport and logistics developing is still in the early stage despite the considerable progress had achieved. Specific performance are as follows: weak infrastructure in port logistics on a small scale, the utilization of information system is not high which lead to high cost, meanwhile, professionals are extremely deficient and lack of awareness of modern logistics. Port logistics industry in china will face enormous challenges, thus it is essential to evaluation and research the systems engineering of port logistics.

1. Connotation of vulnerability of the port logistics system

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Vulnerability of logistics system is essential characteristics of port. The change of any part which relies on port will lead to a change in the whole system including transport, industry and trade, finance, information and multimodal transport. In this way, it disrupts the steady-state mechanism and increase instability of system.

The meaning of this definition contains the following four meanings.

1.1. Dynamism

Port logistics system is not only a complex structure, but also has close contact with external environment. Meanwhile, Port logistics system evolves a higher level in space and time.

1.2. Responsibility

Port logistics system is the combined result of internal factors and external factors. Changes in each of these factors will impact on the system, therefore, Port logistics system can be destroyed as long as external factors changed, and it is a negative effect.

1.3. Time delays

Port Logistics is a total system with time-series-type which connected by many subsystems. Damage within the inner system changes with variations when feedback forms. Maybe it will delay, but the lag has the hidden. At the same time the negative effect accumulated stronger, result the sudden collapse of the port logistics system.

1.4. Directivity

Port logistics need to input human resources, material resources, energy resources, and information resources like other economic systems, however its output is intangible services which formulated in advance.

In all, vulnerability is characteristics existed in any system, it is the negative quantitative in the development of system. It is difficult to control if left unchecked.

2. Research on vulnerability of logistics system

Basic elements of logistics activities in the port include the number of the fluid, carrier status, whether the flow is reasonable or not, the level of function of port logistics and other elements will result vulnerability of the port logistics. This paper studies the vulnerability of the port logistics through analysis of each factor.

2.1. Geography and natural environment

Subsystem of natural and geographical conditions is determined by regional conditions and natural conditions, it includes regional conditions, land area and shoreline conditions, port anchorage conditions, tides and other meteorological and hydrological geological conditions. Location of the port logistics system not only provides the basic operating environment but also important to enhance radiation of port logistics system, port logistics system and so on. Natural conditions include geology, hydrology, climate,

water area, channel depth, etc. It determines the value and scale of port development which influence essential attribute of the port in port planning, construction, production and operation, etc.

2.2. Port logistics infrastructure

Subsystem of port logistics infrastructure is composed by operation facilities and equipment include the port facilities, waterways, terminals and library field production facilities, support facilities, etc. it is the material basis of port logistics system protect the basic conditions for successful operation by providing the necessary facilities, parking and storage yard, production facilities. Well-found port facilities improve the speed and efficiency of cargo handling, determines the position of port system and the scope of the economic hinterland.

2.3. Port logistics support system

Port hinterland economy is the decisive conditions for the formation of port logistics, it affects the level of development of cargo flows directly, they have a positive correlation. The port hinterland economy can be reflected through capacity of the container, GDP of port city, GDP growth rate of port city. At the same time, transport subsystem provide important infrastructure and convergence spaces for carriage of passengers and goods, it is the vital support conditions for the existence and development of port.

2.4. Geography and natural environment

Operational subsystem is the core of the port logistics system and largely determine the port capacity and efficiency. It is the core resources to improve quality and enhance the competitiveness. The current level of port logistics operations including port cargo throughput, cargo throughput growth, foreign trade throughput, growth rate of foreign trade import and export, port container throughput, growth rate of container throughput, route coverage, the proportion of transfer cases, Import and export volume, growth rate of total retail sales of social consumer goods.

2.5. Port logistics management and service level

Soft environmental conditions of port logistics play a significant role compared to hard environment. Management of the port including port management system, regulations, information; Integrated services refers to a series of inspection embodied in the efficiency of port operations, port congestion and the degree of time. It affects the speed and economic benefits directly.

From the above analysis, there are many factors impact on Port logistics, each factor is not independent but complementary. Natural and geographical conditions are prerequisites for port logistics operations, in turn, the development of science and technology require the port gradually improve its natural and geographical conditions. Infrastructure is the material basis of port logistics operations.

3. Case Studies：take Tianjin for example

Tianjin port is located in the west of Bohai bay. Compared with other places in the Circum-Bohai-Sea Region it has the shortest distance with north, northwest and other inland area, which is also the sea gateway of capital Beijing and the shortest easternmost point of departure of Asian European. Tianjin Port is the largest artificial harbor, water area is nearly 200 square kilometers, land area is 37 square

kilometers, Port planning area is 80 square kilometers. Tianjin Port is divided into three parts, that is northern, southern and Haihe district. There are more than 140 types of berths including 76 berths, 55 ton berths, shoreline length of 14,000 meters berth. Berth capacity is 117 million tons which are 3.55 million containers. Tianjin Port is the largest bulk cargo in china.

3.1. Construct index system

Index system is the key to evaluate, Vulnerability assessment can be drawn According to above research. This paper construct a three-level index system, overall objective is vulnerability is of logistics system, The second level is criterion including Geography and natural environmental factors, infrastructure factors, port logistics support factors, operational status, port logistics management and service level. The third level is index. According to the principle of comprehensive and significant, the indicators are selected as follows.

Table 1. Index system

Destination Layer A	Action level B_i	Index strata Cj	Source of data
	Geography and natural environmental factors	The depth of main channel	Statistics
		Port-ton berths	
		GDP of the port	
		Import and export volume of foreign trade	
		Length of coastline	
	Infrastructure factors	Library market area	Statistics
		Number of loading and unloading equipment	Expert scoring
		Total berths	
		Number of container berths	
	Port logistics support factors	GDP growth rate of the port	Statistics
		Port road density	
		Port Railway network density	
	Operation Status	Port cargo throughput	Statistics
		Import and export value	
		Container throughput	
		Growth rate of total retail sales	
		The proportion of transfer cases	
	Port logistics management and service level	The extent of Ship time delay	Statistics
		The efficiency of port operations	Expert scoring
		Port congestion	

3.2. Evaluation methods

- 3.2.1 Criterion weight
- In this paper, analytic hierarchy process (AHP) is selected to evaluate the various factors. The approach is proposed by A. L. Saaty in 20th century. Experts and decision makers listed the degree

of each factor step by step. Determine the weight of each index according to the feature vector in matrix; provide the basis for decision makers.

$$w_i = [w_1 \quad w_2 \quad w_3 \quad w_4 \quad w_5]^T = [0.304 \quad 0.212 \quad 0.245 \quad 0.140 \quad 0.099]^T$$
$$w_1 = [w_{11} \quad w_{12} \quad w_{13} \quad w_{14} \quad w_{15}] = [0.112 \quad 0.063 \quad 0.033 \quad 0.033 \quad 0.063]$$
$$w_2 = [w_{21} \quad w_{22} \quad w_{23} \quad w_{24}] = [0.053 \quad 0.053 \quad 0.053 \quad 0.053]$$
$$w_3 = [w_{31} \quad w_{32} \quad w_{33}] = [0.040 \quad 0.132 \quad 0.073]$$
$$w_4 = [w_{41} \quad w_{42} \quad w_{43} \quad w_{44} \quad w_{45}] = [0.049 \quad 0.017 \quad 0.034 \quad 0.022 \quad 0.018]$$
$$w_5 = [w_{51} \quad w_{52} \quad w_{53}] = [0.049 \quad 0.025 \quad 0.025]$$

- 3.2.2 The executive membership

The causes of vulnerability and performance have clear connotation and definite epitaxial. The uncertain Data can be processed through fuzzy evaluation, probability and mathematical statistics and gray system, the scope of application is different. The vulnerability of the region is divided into four, very vulnerable, fragile, stable and very stable, First-order coefficient matrix is $u = [0.1 \quad 0.4 \quad 0.6 \quad 0.9]$, the level of vulnerability is determined according to Ci, When it belongs to a class, take such rij as 1, and the remaining is 0; If the range between the two types of vulnerability, 0<rij,rij+1<1 and rij＋rij+1＝1. Ri can be expressed as follows:

$$R_i = \begin{bmatrix} r_{11} & r_{12} & r_{13} & r_{14} \\ \vdots & & & \\ r_{i1} & r_{i2} & r_{i3} & r_{i4} \end{bmatrix}$$

Comprehensive vulnerability matrix Bi $v_i = R_i \bullet u^T = \begin{bmatrix} r_{11} & r_{12} & r_{13} & r_{14} \\ \vdots & & & \\ r_{i1} & r_{i2} & r_{i3} & r_{i4} \end{bmatrix} \bullet \begin{bmatrix} 0.1 \\ 0.4 \\ 0.6 \\ 0.9 \end{bmatrix}$

Comprehensive vulnerability Bi $V_i = w_i \bullet v_i = \begin{bmatrix} w_{i1} & \cdots & w_{i2} \end{bmatrix} \bullet \begin{bmatrix} v_{i1} \\ \vdots \\ v_{i2} \end{bmatrix}$

- In the paper, the cause constituent elements of vulnerability are geographical and natural environmental factors, infrastructure factors and port logistics support factors. The result constituent elements of vulnerability are operational status, port logistics management and service level. The vulnerability of Tianjin port can be calculated V=0. 3336, performance results of vulnerability is V=0.1420

3.3. Evaluation results and analysis

From the above analysis, the causes of vulnerability is higher than the results of vulnerability, that is to say, Geography and natural environmental factors, infrastructure factors, port logistics support are more stable than operational status, port logistics management and service level. This is advantages of Tianjin Port. However, most of the land are plateau, desert and arid steppe, Low level of economic development, it is a key development in our future. Its export-oriented economy develops slowly, foreign trade exports accounted for only 6.3% of GDP below the national average. Ship Port is serious pressured and lack of terminal facilities are barriers to the development of the port. As to Tianjin Port, Throughput capacity not yet reached 15 million tons, transport problems have not been fundamentally resolve. The proportion of Tianjin Port's international container transit is small, the highest efficiency can be achieved 300TEU/h,

Single bridge operating efficiency of container can be achieved 33TEU/h, it is has a wide range compared to international standards. Collection and distribution of Tianjin port currently rely mainly on road, rail, it has brought a degree of vulnerability to the development of Tianjin.

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